PATENT ABSTRACTS OF JAPAN

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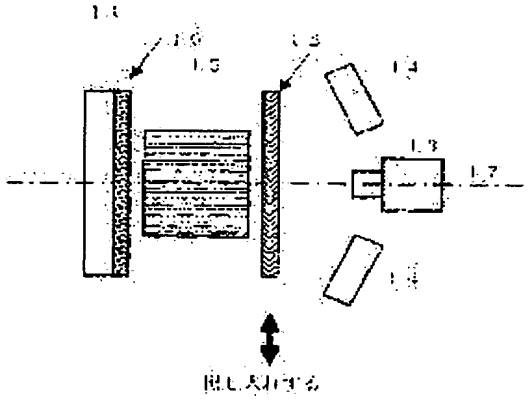
(54) INSPECTION DEVICE AND INSPECTION METHOD FOR THROUGH HOLE

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a through-hole clogging inspection device for a honeycomb-shaped object by means of comparison with a previously photographed reference image, suffering no deterioration in accuracy, and dispensing with an expensive large-diameter telecentric lens.
SOLUTION: This inspection device has a main part comprising a diffused illumination lamp for transmitted light, a diffusion plate, a camera, and at least two illumination lamps for reflected light. The diffusion plate is provided parallel to a diffused illumination plane for transmitted light and capable of being put into or out of an optical path at a distance allowing the honeycomb-shaped object to be provided between the diffusion plate and the illumination lamp for transmitted light so as to cause the through hole center line of the honeycomb-shaped object to be vertical to the illumination plane for transmitted light. The camera is provided so that the center line of a lens of the camera is vertical to the illumination plane for transmitted light, and at least two illumination lamps for reflected light are provided centering around the camera at equal intervals so as to illuminate the honeycomb- shaped object.



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CLAIMS

[Claim(s)]
[Claim 1]
It is equipment for inspecting the existence of lock out of the through tube of a honeycomb configuration object. The principal part The diffused lighting for the transmitted lights, It consists of a diffusion plate, and a camera and at least two lighting for the reflected lights. A diffusion plate at spacing in which it is prepared and a honeycomb configuration object deals between this diffusion plate and this diffused lighting for the transmitted lights so that the through tube center line of this honeycomb configuration object and the diffused lighting side for the transmitted lights may become perpendicular It is prepared possible [the diffused lighting side for the transmitted lights, parallel, and receipts and payments in an optical path]. Test equipment characterized by having formed the camera so that the center line of the lens of this camera might become perpendicular to the diffused lighting side for the transmitted lights, and being prepared so that at least two lighting for the reflected lights may begin to illuminate a honeycomb configuration object at equal intervals centering on a camera.
[Claim 2]
The inspection approach of the through tube characterized by being the approach of inspecting the through tube of a honeycomb configuration object, and mainly including the following processes.
1) The process which incorporates the reflected image of opening of a honeycomb configuration object to a camera, and acquires this reflected image.
2) The process which carries out the image processing of the reflected image, and determines the range to be examined.
3) The process which incorporates to a camera the transparency image which projected on the diffusion plate the transparency image of the honeycomb configuration object by the transmitted light emitted from the diffused lighting plate for the transmitted lights, and was projected on this diffusion plate.
4) The process which judges whether the image processing of the transparency image is carried out, and the lock out section is in the range to be examined.
[Claim 3]
The inspection approach of the through tube characterized by being the approach of inspecting the through tube of a honeycomb configuration object using test equipment according to claim 1, and mainly including the following processes.
1) The process which floodlights in a honeycomb configuration object with reflected light lighting where a diffusion plate is sent out of the optical path of the transmitted light, incorporates the reflected light of this honeycomb configuration object to a camera, and acquires a reflected image.
2) The process which carries out the image processing of the reflected image, and determines the range to be examined.
3) The process which puts in a diffusion plate in the optical path of the transmitted light, projects on a diffusion plate the image of the transmitted light emitted from the diffused lighting plate for the transmitted lights, and incorporates the projected transparency image to a camera.
4) The process which judges whether the image processing of the transparency image is carried out, and the lock out section is in the range to be examined.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]
This invention relates to the image test equipment which inspects the existence of the blinding of this through tube of the body which has the through tube of a large number which aligned in the one direction.
[0002]
[Description of the Prior Art]
There is a honeycomb used for what was well known as a body which has the through tube of a large number which aligned in the one direction as an odor removal filter. Moreover, there is a thing which rolled the aggregate of many pipes and a wave-like plate to have the similar structure of this.
[0003]
The through tube is an important semantic **** thing, and when this through tube is blockaded, it becomes impossible to use the thing of the above-mentioned honeycomb configuration. Therefore, inspection of whether this through tube is blockaded is needed.
[0004]
As shown in drawing 3 , light from the light source 1 like a halogen lamp is made into a parallel ray with a lens 2, the center line of the through tube of this honeycomb configuration object becomes parallel to a parallel ray about the honeycomb configuration object 4 to be examined, and the conventional image test equipment which makes this purpose attain is installed so that a parallel ray may pass this through tube. And the transparency image of a honeycomb configuration object is projected on a screen 5, and a photograph is taken with the camera 7 equipped with a lens 6. Or as shown, for example in drawing 4 , the transmitted light of a honeycomb configuration object is photoed with the camera 7 equipped with the direct tele cent rucksack lens 8. In this way, the obtained image was analyzed and the existence of lock out of a through tube was inspected.
[0005]
As the image-analysis approach in this case is shown in drawing 5 , the inspection object which does not have blinding beforehand is saved as a criteria image A. When this image is compared with the inspection image B obtained by the above-mentioned technique and the dark pixel below setting concentration (it is 128 at the image concentration of for example, 256 gradation) exceeds the number of setting pixels (for example, 100 pixels) from a criteria image, it is judged that a lock out part is in the through tube of this inspection object.
[0006]
By the way, since such a conventional image-analysis approach is compared with the criteria image photoed beforehand, at the actual time of inspection, lighting reinforcement only differed from the camera station etc. slightly, and it may mistake decision of a quality judging. Moreover, by the approach of drawing 4 , when an inspection object becomes large, a very expensive diameter of macrostomia tele cent rucksack lens is needed.
[0007]
[Problem(s) to be Solved by the Invention]
This invention aims at offer of the test equipment of a honeycomb configuration object through tube without the above-mentioned fault, and the inspection approach.
[0008]
[Means for Solving the Problem]
Invention of this first which solves the above-mentioned technical problem is equipment for inspecting the

existence of lock out of the through tube of a honeycomb configuration object. The principal part The diffused lighting for the transmitted lights, It consists of a diffusion plate, and a camera and at least two lighting for the reflected lights. A diffusion plate at spacing in which it is prepared and a honeycomb configuration object deals between this diffusion plate and this diffused lighting for the transmitted lights so that the through tube center line of this honeycomb configuration object and the diffused lighting side for the transmitted lights may become perpendicular It is prepared possible [the diffused lighting side for the transmitted lights, parallel, and receipts and payments in an optical path]. It is test equipment which the camera was formed so that the center line of the lens of this camera might become perpendicular to the diffused lighting side for the transmitted lights, and was prepared so that at least two lighting for the reflected lights might begin to have illuminated a honeycomb configuration object at equal intervals centering on a camera.

[0009]

And invention of **** 2 is the approach of inspecting the through tube of a honeycomb configuration object, and it is the inspection approach of the through tube characterized by mainly including the following processes.

1) The process which incorporates the reflected image of opening of a honeycomb configuration object to a camera, and acquires this reflected image.

2) The process which carries out the image processing of the reflected image, and determines the range to be examined.

3) The process which incorporates to a camera the transparency image which projected on the diffusion plate the transparency image of the honeycomb configuration object by the transmitted light emitted from the diffused lighting plate for the transmitted lights, and was projected on this diffusion plate.

4) The process which judges whether the image processing of the transparency image is carried out, and the lock out section is in the range to be examined.

[0010]

And invention of **** 3 is the approach of inspecting the through tube of a honeycomb configuration object using the measuring device of this first, and mainly includes the following processes.

1) The process which floodlights in a honeycomb configuration object with reflected light lighting where a diffusion plate is sent out of the optical path of the transmitted light, incorporates the reflected light of this honeycomb configuration object to a camera, and acquires a reflected image.

2) The process which carries out the image processing of the reflected image, and determines the range to be examined.

3) The process which puts in a diffusion plate in the optical path of the transmitted light, projects on a diffusion plate the image of the transmitted light emitted from the diffused lighting plate for the transmitted lights, and incorporates the projected transparency image to a camera.

4) The process which judges whether the image processing of the transparency image is carried out, and the lock out section is in the range to be examined.

[0011]

[Embodiment of the Invention]

As shown in drawing 1 , the principal part invention of this first The diffused lighting 11 for the transmitted lights, It consists of a diffusion plate 12, and a camera 13 and at least two lighting 14 for the reflected lights. The diffusion plate 12 at spacing in which it is prepared and the honeycomb configuration object 15 deals between this diffusion plate 12 and this diffused lighting 11 for the transmitted lights so that the through tube center line of this honeycomb configuration object 15 and the diffused lighting side 16 for the transmitted lights may become perpendicular It is prepared possible [the diffused lighting side 16 for the transmitted lights, parallel, and receipts and payments in an optical path]. It is test equipment which the camera 13 was formed so that the center line 17 of the lens of this camera 13 might become perpendicular to the diffused lighting side 16 for the transmitted lights, and was prepared so that two lighting 14 and 15 for the reflected lights might begin to have illuminated the honeycomb configuration object 15 at equal intervals centering on a camera 13.

[0012]

The reflected image of opening of a honeycomb configuration object is incorporated to a camera so that the first above-mentioned invention may show the principle of this invention. Acquire this reflected image, and carry out the image processing of the acquired reflected image, and the range to be examined is determined. The transparency image of a honeycomb configuration object is projected on a diffusion plate, without changing the physical relationship of a honeycomb configuration object and a camera. It is invention which

incorporated to the camera the transparency image projected on this diffusion plate, uses to judge whether the image processing of the transparency image is carried out, and the lock out section is in the range to be examined as main elements, and was indicated by claim 2.

[0013]

Invention of **** 3 indicated by claim 3 is the inspection approach performed using the test equipment of invention of this first. In invention of **** 3, when photoing this honeycomb configuration object front face, irradiating reflected illumination on the front face of a honeycomb configuration object, a diffusion plate is removed out of a system, the diffused lighting for the transmitted lights is erased, and the reflected image of a honeycomb shaped surface is photoed. Here, when taking a photograph using reflected illumination, a diffusion plate is removed out of a system, because the reflected light (return) from an exposure (going) and opening profile of lighting diffuses with a diffusion plate and cannot photo an image with a clear opening profile.

[0014]

And irradiating reflected illumination, an image processing extracts the profile on the front face of opening of the reflected image photoed with the camera (parts other than a hole), and the inspection exclusion range is set up. Next, the through tube image of a honeycomb configuration object inserts a diffusion plate into a system, turns on the diffused lighting for the transmitted lights, and obtains it by photoing with a camera the image projected on a diffusion plate. And it judges whether the image processing of this image is carried out, and the lock out section is in a through tube part. In addition, about the sequence of acquiring a reflected image and a transparency image in the approach of this invention, it is arbitrary, and it is convenient whichever you make it precede.

[0015]

The concrete example of image analysis is shown in drawing 2 . To the inspection object, six holes are open. An inspection exclusion range threshold (it is 180 when for example, image concentration is 256 gradation) is set to a reflective image (A), and let the image concentration part more than an inspection exclusion range threshold be the inspection range outside the hall. Furthermore, a blinding decision threshold (it is 170 when for example, image concentration is 256 gradation) is set as a transparency image (B), and it is judged that the hole where it is range other than the inspection exclusion range, and the pixel below a blinding decision threshold is contained is carrying out blinding.

[0016]

In this invention, since the diffused light is used for acquiring a transparency image, even if the foreign matter has adhered to a part of one hole, the foreign matter is not radiographed, but the average transmission coefficient of the hole falls according to the size of a foreign matter, and it becomes a dark image.

[0017]

[Example]

Next, this invention is further explained using an example.

(Example 1)

The through tube of 0.8mm angle used the honeycomb which is vacant at intervals of [about 4500] 1mm in parallel as an inspection object by the diameter of 75mm, and die length of 150mm. a CCD camera -- a 1024x1024-pixel thing -- using -- a pixel -- the lens was used so that resolution might become [pixel] in 0.1mm /. Therefore, 8x8=64 pixel corresponds to the area of one through tube about.

[0018]

In this example, the blinding test equipment of this invention which has the configuration shown in drawing 1 was used. First, the diffusion plate was removed besides the system, the diffused lighting plate for the transmitted lights was quenched, with reflected illumination, the opening front face (field which can be seen) of a honeycomb was illuminated with reflected light lighting, and the reflected image on a broth and this front face of opening was photoed. Like what showed the acquired image to drawing 8, the profile of a honeycomb was bright and the hole became dark.

[0019]

This image was recorded as data of 256 gradation, the threshold of the inspection removal range was set as 180, and the part more than this threshold (namely, except a hole) was removed from the inspection range.

[0020]

Next, the diffusion plate was returned to the position, reflected light lighting was erased, the diffused lighting plate for the transmitted lights was turned on, the image of the transmitted light was projected on the diffusion plate, and the transparency image was photoed. At this time, each spacing of the diffused lighting plate for the transmitted lights, a honeycomb and a diffusion plate, and a honeycomb was set to

2mm.
[0021]
Next, the image processing of the acquired image was carried out. It was presupposed that a blinding decision threshold is set to 170 and blinding of the through tube in which the pixel below a blinding decision threshold is contained in the inspection range is carried out. Labeling processing was performed and it asked for the number of the through tube which is carrying out blinding, after carrying out 1-pixel expansion contraction processing of the pixel detected here.
[0022]
For the comparison, blinding inspection was conducted by the conventional approach using the same honeycomb as the above. It was judged that the hole where the pixel below a blinding decision threshold is contained by inspection images other than the dark part (parts other than a hole) of a criteria image was carrying out blinding. Labeling processing was performed and it asked for the number of the hole which is carrying out blinding, after similarly carrying out 1-pixel expansion contraction processing of the pixel detected here.
[0023]
3 times of the blinding inspection results by the equipment of this invention and conventional equipment were shown in Table 1.

表 1

検査対象物	目詰まり穴の個数	
	本発明の方法	従来の方法
NO.1	12	17
NO.2	6	11
NO.3	25	39

As shown in Table 1, the approach of this invention has little number of the blinding hole of an inspection result compared with the conventional approach. If very exact alignment is required for this by the conventional approach so that the center line of the parallel flux of light which is the transmitted light, and a hole may become parallel, and this alignment is not exact, the hole which has not carried out blinding will also become dark and it will be considered that it was judged that blinding was carried out.
[0024]
[Effect of the Invention]
This invention searches for the reflected image and transparency image of a honeycomb configuration object, keeping constant the physical relationship of a honeycomb configuration object and a camera using a diffusion plate, the diffused lighting for the transmitted lights, and the lighting for the reflected lights, and inspects the blinding of the through tube of a honeycomb configuration object by the image processing. Therefore, there is no decision mistake of the quality judging by lighting reinforcement differing from a camera station etc. slightly in the time of acquiring the time of the physical relationship of a honeycomb configuration object etc. and a camera acquiring a reflected image and a transparency image, since it is eternal. Moreover, in order to use a diffusion plate, even if a honeycomb configuration object etc. becomes large-sized, an expensive diameter of macrostomia tele cent rucksack lens is not needed.
[Brief Description of the Drawings]
[Drawing 1] It is the schematic diagram of the test equipment of this invention.
[Drawing 2] It is drawing having shown the example of image analysis of this invention.
[Drawing 3] It is the schematic diagram of conventional test equipment.
[Drawing 4] It is the schematic diagram of the conventional test equipment using a tele cent rucksack lens.
[Drawing 5] It is drawing having shown the conventional example of image analysis.
[Description of Notations]
1 ---- Light source
2 ---- Lens
3 ---- Parallel ray
4 ---- Honeycomb configuration object

5 ---- Screen
6 ---- Lens
7 ---- Camera
8 ---- Tele cent rucksack lens
11 --- Diffused lighting for the transmitted lights
12 --- Diffusion plate
13 --- Camera
14 --- Lighting for the reflected lights
15 --- Honeycomb configuration object
16 --- Diffused lighting side for the transmitted lights
17 --- Center line of a lens

[Translation done.]

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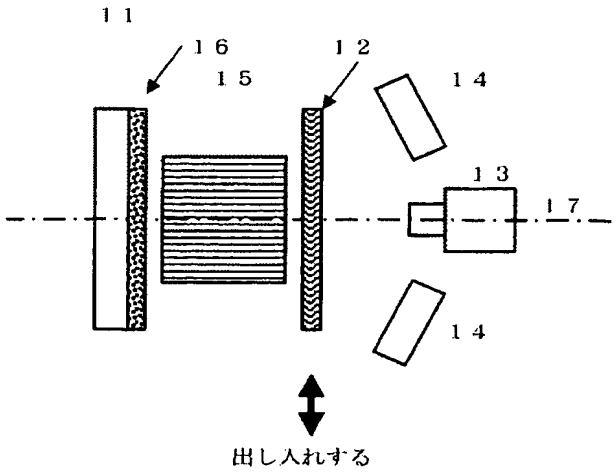
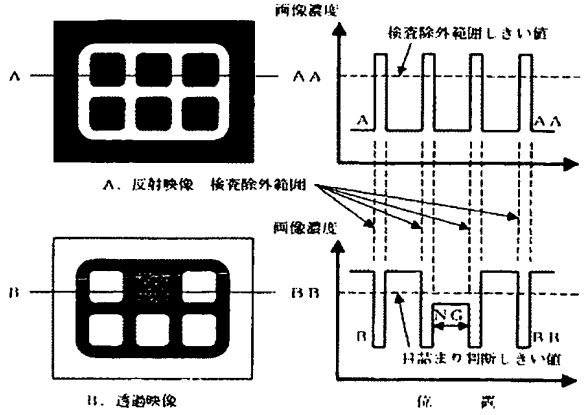
DRAWINGS

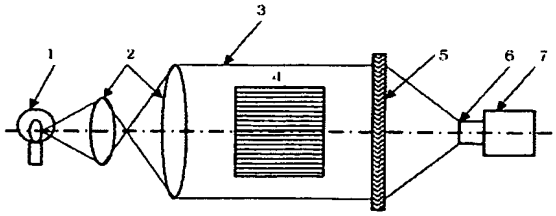
[Drawing 1]



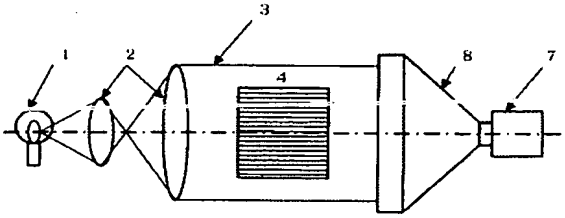
[Drawing 2]



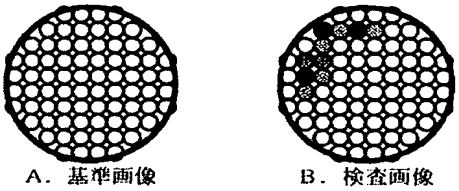
[Drawing 3]



[Drawing 4]



[Drawing 5]



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